Lec9: Electric Machines 6-5-2015

Three phase induction motor

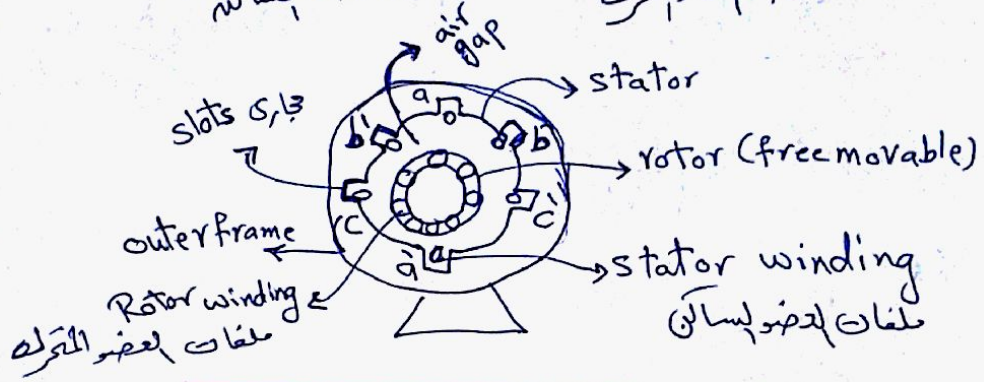
المحرك الحثي ثلاثي الأوجه (تيار متردد)

* Outline

1- Construction of 3-ϕ induction motor
2- Principle of operation
3- Rotor speed & slip
4- Frequency of induced voltage in rotor
5- Example

1- Construction of I.M (Induction Motor)

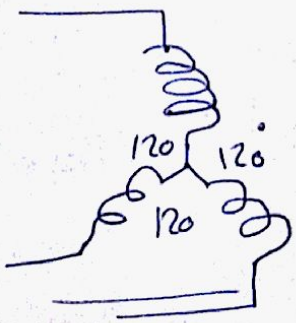
- Enclosure غلاف خارجي (Yoke)
- Stator الساكن
- Rotor العضو المتحرك

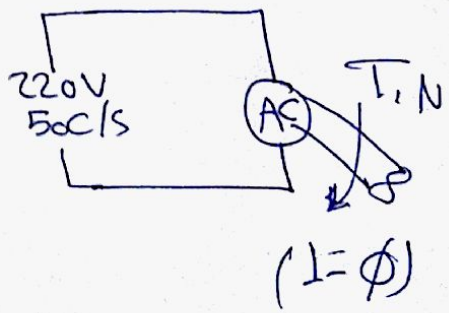


Q- * Explain the Construction of IM
* " " Principle of operation of IM

AC

- 3-Phase (3-ϕ)
- Single phase





(1-ϕ)

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final * Explain the principle of operation of single Phase transformer ?
* " " " " " " Induction Motor ?

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3 Induction Motor (Rotor) speed & slip سرعة المحرك والانزلاق

* Can the induction Motor runs at the Synchronous speed?
هل يمكن للمحرك الحثي العمل عند السرعة التزامنية؟

No

- stator (Main) Magnetic field المجال المغناطيسي الرئيسي
  rotate with constant speed "Synchronous speed (n_s)"

* $n_s = \frac{120f}{P} = \frac{120\,(\text{frequency of supply})}{P\,(\text{no of magnetic poles})}$
* $n_s = \frac{120f\,(c/s)}{P} = r.p.m$

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* Difference between rotor speed & Synchronous speed is called "slip speed" سرعة الانزلاق

$$n_{slip} = n_s - n_r$$

n_{slip} = slip speed
n_s = Synchronous speed
n_r = Rotor speed

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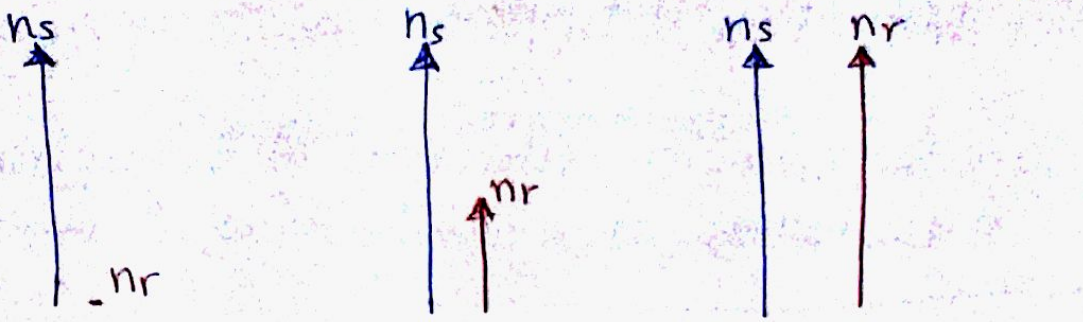
* Slip, S معامل الانزلاق

$$S = \frac{n_{slip}}{n_s} = \frac{n_s - n_r}{n_s}$$

$$n_r = n_s(1 - S)$$

$$S\% = \frac{n_s - n_r}{n_s} * 100\% \quad \leftarrow \% \text{ form}$$



Stand still
$n_r = 0$

$0 < n_r < n_s$

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* the frequency of rotor current = the frequency of the supply
* f_r = frequency of voltage induced in rotor winding
* $n_{slip} = n_s - n_r = n_s = \frac{120 f_r}{P}$

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* **At running**

$$n_{slip} = n_s - n_r = \frac{120 f_r}{P}$$

$$n_s = \frac{120 f}{P}$$

$$\therefore \frac{f_r}{f} = \frac{n_s - n_r}{n_s}$$

$$\therefore f_r = \frac{n_s - n_r}{n_s} \Rightarrow \boxed{f_r = Sf}$$

* at stand still : $\boxed{S = 1}$, $\boxed{f_r = f}$

Example: A 3ϕ induction motor 400 volt, 100 HP, 60 Hz delivers rated power at a slip 5%

Find: n_s, n_r, f_r, n_{slip}

Solution:

$$n_s = \frac{120 f}{P} = \frac{120(60)}{4} = 1800 \text{ r.p.m}$$

$$n_r = (1 - S) n_s = (1 - 0.05)\, 1800 = 1710 \text{ r.p.m}$$

$$f_r = Sf = 0.05(60) = 3 \text{ c/s}$$

$$n_{slip} = n_s - n_r = 1800 - 1710 = 90 \text{ r.p.m}$$
